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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|--------------------------|-------------|----------------------|---------------------|------------------|
| 09/293,188 | 04/16/1999 | ZHIPING YIN | 11675.165.1 | 4546 |
| 24247 | 7590 | 10/20/2006 | | EXAMINER |
| TRASK BRITT | | | | CAO, PHAT X |
| P.O. BOX 2550 | | | | |
| SALT LAKE CITY, UT 84110 | | | | |
| | | | ART UNIT | PAPER NUMBER |
| | | | | 2814 |

DATE MAILED: 10/20/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | |
|------------------------------|-------------------------|---------------------|--|
| Office Action Summary | Application No. | Applicant(s) | |
| | 09/293,188 | YIN ET AL. | |
| | Examiner Phat X. Cao | Art Unit 2814 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) Responsive to communication(s) filed on 23 August 2006.
- 2a) This action is FINAL. 2b) This action is non-final.
- 3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) Claim(s) 31-38 and 40-48 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) Claim(s) _____ is/are allowed.
- 6) Claim(s) 31-33, 40-48 is/are rejected.
- 7) Claim(s) 34-38 is/are objected to.
- 8) Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) The specification is objected to by the Examiner.
- 10) The drawing(s) filed on _____ is/are: a) accepted or b) objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) All b) Some * c) None of:
 1. Certified copies of the priority documents have been received.
 2. Certified copies of the priority documents have been received in Application No. _____.
 3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) Notice of References Cited (PTO-892)
- 2) Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) Notice of Informal Patent Application
- 6) Other: _____

DETAILED ACTION

1. The Request for Continued Examination filed on 8/29/06 is acknowledged.

Claim Objections

2. Claims 31-32 are objected to because of the following informalities:

In claim 31, line 11, "a chemical composition" should be changed to "the chemical composition".

In claim 31, line 11, "a second dielectric layer" should be changed to "the second dielectric layer".

In claim 32, line 2, "an electrically conductive material" should be changed to "the electrically conductive layer".

Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 40-44, and 45-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sekiguchi et al (US. 5,780,908) in view of Liao (US. 6,114,238).

Regarding claims 40-43, and 45-47, Sekiguchi (Figs. 3a-3b) discloses a method of forming an electrically conductive structure, comprising: forming a first dielectric layer 4 on a silicon semiconductor structure 1, the first dielectric layer 4 comprising a depression 5 therein; filling the depression 5 with an unoxidized electrically conductive

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material 7 of tungsten; and reacting a chemical composition with an upper surface of the tungsten electrically conductive material 7 by exposing the surface of the tungsten conductive material 7 to plasma in an atmosphere of nitride (column 12, lines 31-37) or ammonia (NH₃) (column 15, lines 50-54) for nitriding an area in the vicinity of the surface of the tungsten conductive material 7 to form a chemical compound layer 7b of tungsten nitride (column 12, lines 35-37), wherein the plasma in an atmosphere of ammonia allows ions of ammonia (NH₃) to enter or adsorb the tungsten conductive material 7 (column 11, lines 28-35).

It is noted that where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, claimed properties or functions are presumed to be inherent. *In re Best*, 195 USPQ 430, 433 (CCPA 1977). Therefore, the tungsten nitride chemical compound layer 7b of Sekiguchi would have properties of providing more resistant to oxidation than the tungsten conductive material 7 because the chemical compound layer 7b of Sekiguchi is substantially identical in structure or composition (i.e., tungsten nitride) to the chemical compound layer 32 of Applicant (see page 11 of Applicant's specification, lines 4-7) and because the chemical compound layer 32 of Applicant is produced by substantially identical processes (i.e., exposing the surface of tungsten refractory material to plasma in an atmosphere of ammonia, NH₃).

Sekiguchi does not disclose the forming of a second dielectric layer over the conductive material and the first dielectric layer, and being adhered to the conductive material.

However, Liao (Fig. 2D) teaches the forming of an inter-metal dielectric or a second dielectric layer 108 (not shown in Fig. 2D, see Fig. 1 and column 2, lines 29-30) over the conductive material (208, 212a) and the first dielectric layer 202. Accordingly, it would have been obvious to form a second dielectric layer over the conductive material 7b and the first dielectric layer 4 of Sekiguchi because such second dielectric layer would provide an inter-metal dielectric for a multi-level metal interconnect structure, as taught by Liao (see Fig. 1, column 1, lines 30-35 and column 2, lines 62-67).

Regarding claim 48, as discusses above, Sekiguchi (Figs. 3a-3b) also discloses that the depression 5 is filled with a tungsten refractory metal 7, and the tungsten nitride 7b on the upper surface of the tungsten refractory metal 7 is formed by reacting the chemical composition of ammonia (NH₃) with the upper surface of the tungsten refractory metal 7 (column 12, lines 31-37 and column 15, lines 50-54).

Regarding claim 44, Sekiguchi further discloses that heating the first dielectric layer 4 to a temperature of 50 degrees Celsius, and exposing the upper surface to the nitrogen-containing composition to form the chemical compound layer 7b of tungsten nitride (column 12, lines 31-37).

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless -

- (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

6. Claims 31-33, 40, and 45 are rejected under 35 U.S.C. 102(a) as being anticipated by Applicant's admitted prior art.

Regarding claims 31, 40 and 45, Applicant's admitted prior art (Fig. 1 and page 3 of specification) discloses a method comprising: forming a first dielectric layer 14 on a semiconductor structure 10, the first dielectric layer 14 comprising a depression therein; filling the depression with an unoxidized conductive material 12 of tungsten; reacting a chemical composition with an upper surface of the conductive material 12 to form a chemical compound 20 of tungsten oxide (see page 3, lines 15-16); and forming a second dielectric layer 18 over the conductive material 12 and the first dielectric layer 14 and adhering the second dielectric layer 18 to the electrically conductive material 12, wherein reacting the chemical composition and depositing the second dielectric layer 18 occur simultaneously (see page 3, lines 14-15). It is noted that the chemical compound 20 of tungsten oxide is more resistant to oxidation than the conductive material 12 of tungsten because tungsten oxide is an insulating material and tungsten is a metal material.

Regarding claims 32-33, the admitted prior art (Fig. 1) further discloses that the filling the depression with the conductive material 12 comprises filling the depression with tungsten refractory metal and the reacting the chemical composition with the upper surface of the electrically conductive material 12 comprises reacting the chemical composition with at least one monolayer of the upper surface of the conductive material 12 to form tungsten oxide layer 20 (see page 3, lines 14-16).

Allowable Subject Matter

7. Claims 34-38 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The prior art of record fails to disclose the combination of the steps comprising: reacting the upper surface of the conductive material to the nitrogen-containing composition, and forming the second dielectric layer occurring simultaneously.

Response to Arguments

8. Regarding claims 31-38, in response to Applicant's arguments that Sekiguchi does not suggest the step of reacting the chemical composition and forming the second dielectric layer occurring simultaneously as amended, the rejections of claims 31-38 are withdrawn.

Regarding claims 40-48, Applicant argues that it would not be obvious to combine Liao with Sekiguchi for forming a second dielectric layer over the conductive material and the first dielectric layer, and adhering to the conductive material because "...Liao teaches that depositing a second dielectric layer over a metal plug leads to reliability problems ..." (page 8 of Applicant's remark, first paragraph).

It appears that Applicant is misinterpreted the Liao reference. It is noted that Liao does not teach depositing a second dielectric layer over a metal plug leading to reliability problems, but rather, Liao clearly teaches that depositing a second dielectric layer over a metal plug leads no reliability problems when there is a barrier layer 212a formed on the upper surface of the metal plug 208 (column 2, lines 62-67). Therefore,

Liao (Fig. 2D) clearly teaches the forming of a second dielectric layer 108 (not shown in Fig. 2D, see Fig. 1 and column 2, lines 27-30) over the conductive material 208/212a and the first dielectric layer 202 and adhering to the conductive material for providing an inter-metal dielectric for a multi-level metal interconnect structure (see Fig.1 and column 2, lines 30-31). Thus, the motivation of providing an inter-metal dielectric for a multi-level metal interconnect structure would motivate one skilled in the art to combine the references as suggested.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phat X. Cao whose telephone number is 571-272-1703. The examiner can normally be reached on M-F.

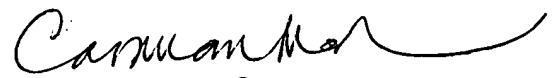
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on 571-272-1705. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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PC
October 14, 2006


PHAT X. CAO
PRIMARY EXAMINER